



**UNIVERSITI PUTRA MALAYSIA**

**GENETICS AND GENETIC RESPONSE IN  
POPULATIONS GENERATED FROM TWO  
CYCLES OF PHENOTYPIC MASS SELECTION  
IN SWEET CORN (ZEA MAYS L. SACCHARATA)**

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FROM TWO CYCLES OF PHENOTYPIC MASS SELECTION IN SWEET  
CORN (*ZEAMAYS L. SACCHARATA*)**

**By**

**ELTAHIR SIDDIG ALI**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

**May 2003**



**DEDICATION**

**TO MY BELOVED PARENTS, BROTHERS, SISTERS  
AND MY SUPPORTING WIFE AWATIF**

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy.

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May 2003

**Chairman : Associate Professor Ghizan Saleh, Ph.D.**

**Faculty : Agriculture**

Local composite varieties of sweet corn (*Zea mays* L. *saccharata*) offer moderate yields and eating quality, while imported hybrid varieties are less adaptable to the local environment, although having good eating quality. A breeding programme was therefore initiated at Universiti Putra Malaysia (UPM), utilising both genetic materials to produce new superior genotypes. The main objectives of this study were to investigate the genetics of populations, and to evaluate genetic response in two sweet corn populations generated from two cycles of phenotypic mass selection.

In Experiment 1, a local composite variety, Manis Madu and two imported hybrid varieties, Hybrid SSC 240 and Hybrid 368 were first evaluated, and found to show comparable performance. Consequently, Manis Madu and Hybrid SSC 240 were chosen as source populations for selection and were then crossed to generate the base population. In Experiment 2, the performance of the cross population was compared to its parents, and was found to show more resemblance to Hybrid SSC 240.

Separately and simultaneously, two cycles of phenotypic mass selection for ear length were employed on the two base populations, Manis Madu, designated as M C0, and the intermated crossed population, designated as MS C0, at Field 2, UPM. The two base populations and the populations generated from the two cycles of selection were then evaluated and compared for general performance at two locations, Field 2 and Share Farm, in UPM.

In Manis Madu populations (M), the predicted responses to individual cycles of selection were almost the same for both cycles, 19.3% in the first cycle and 19.6% in the second. The cumulative predicted response in M C2 population was 43.6%. In the cross populations (MS), the predicted response to individual cycles of selection was higher in the second cycle (26.5%) than it was in the first (16.8%). The cumulative predicted response in MS C2 population was 46.4%.

The two populations responded differently to the two cycles of selection, where, in Manis Madu populations, a positive realised response was only attained in first cycle (4.1%), while a negative one was observed in the second (-0.7%). In contrast, the cross populations showed negative realised response in the first cycle (-0.7%), while a reasonable positive one (2.08%) was observed in the second. The average cumulative realised response to selection was higher in M C2 (3.4%) than that in MS C2 (1.4%). As expected, the realized responses were lower than the predicted.

In the combined analysis, population generated from the second cycle of selection on Manis Madu (M C2), showed significant improvement in fresh husked ear yield

(10996 kg ha<sup>-1</sup>) and dehusked ear length (15.2 cm). The population generated from the second cycle of selection on the cross (MS C2) showed significant improvement in fresh dehusked ear yield, giving 6887 and 6788 kg ha<sup>-1</sup> at Field 2 and Share Farm, respectively. In the combined analysis, MS C2 produced significantly longer dehusked ears (14.7 cm) than did the base population, MS C0 (14.5 cm).

Results of simple phenotypic correlations on traits measured on individual plant samples within the selected populations, showed positive phenotypic correlations between plant height and most of the other traits investigated, including ear height, ear length and number of kernel rows/ear. In addition, positive correlations were also observed among the ear traits, ear length, ear diameter, number of kernel rows/ear and number of kernels/row.

Ear length, which was taken as a criterion for selection in this study, showed moderate broad-sense heritability ( $h^2_B$ ) estimates in the two populations investigated, indicating that selection for this trait in these populations would be effective for expression of this trait in the succeeding generations.

This study has revealed that both the local and imported germplasm materials were useful in the breeding of sweet corn populations. The two cycles of phenotypic mass selection for ear length were found to have shown some improvement in fresh ear yield of the populations. Introgression of foreign genes into the local germplasm might have enriched the available gene pool, although more cycles of selection are required for more pronounced genetic improvement to be realised.

Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia bagi memenuhi syarat untuk mendapatkan ijazah Doktor Falsafah.

**GENETIK DAN TINDAKBALAS GENETIK DALAM POPULASI  
TERBENTUK DARI DUA PUSINGAN PEMILIHAN KASAR FENOTIP  
PADA JAGUNG MANIS (*ZEAMAYS L. SACCHARATA*)**

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Mei 2003

**Pengerusi : Profesor Madya Ghizan Saleh, Ph.D.**

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Varieti-varieti komposit tempatan jagung manis (*Zea mays L. saccharata*) memberikan hasil dan kualiti pemakanan yang sederhana, manakala varieti-varieti hibrid yang diimport kurang kesesuaian pada persekitaran tempatan, walaupun mempunyai kualiti pemakanan yang baik. Oleh itu, satu program pembiakbakaan telah dimulakan di Universiti Putra Malaysia (UPM), menggunakan kedua-dua bahan genetik untuk menghasilkan genotip baru yang unggul. Objektif utama kajian ini ialah untuk mengkaji genetik populasi, dan tindakbalas genetik dalam dua populasi jagung manis yang dibentuk dari dua pusingan pemilihan kasar fenotip.

Dalam Eksperimen 1, varieti komposit tempatan, Manis Madu dan dua varieti hibrid yang diimport, Hibrid SSC 240 dan Hibrid 368 telah pada mulanya dinilai, dan didapati memberikan prestasi yang setara. Berikutan dengan itu, Manis Madu dan Hibrid SSC 240 telah dipilih sebagai populasi sumber untuk pemilihan dan kemudiannya dikacukkan bagi menghasilkan populasi bes. Dalam Eksperimen 2,

prestasi populasi kacukan telah dibandingkan dengan induknya, dan didapati lebih menyerupai Hibrid SSC 240.

Secara berasingan dan serentak, dua pusingan pemilihan kasar fenotip berdasarkan panjang tongkol telah dijalankan terhadap kedua-dua populasi bes, Manis Madu, dinamakan M C0, dan populasi kacukrawak dari kacukan tersebut, dinamakan sebagai MS C0, di Ladang 2, UPM. Dua populasi bes tersebut serta populasi yang dibentuk dari dua pusingan pemilihan kemudiannya dinilai dan dibandingkan untuk prestasi am di dua lokasi, Ladang 2 dan Ladang Kongs, UPM.

Dalam populasi Manis Madu (M), tindakbalas jangkaan dari pusingan individu adalah hampir sama bagi kedua-dua pusingan, 19.3% dalam pusingan pertama dan 19.6% dalam pusingan kedua. Tindakbalas jangkaan kumulatif dalam populasi M C2 adalah 43.6%. Dalam populasi kacukan (MS), tindakbalas jangkaan dari pusingan individu pemilihan adalah lebih tinggi dalam pusingan kedua (26.5%) berbanding pusingan pertama (16.8%). Tindakbalas jangkaan kumulatif dalam populasi MS C2 adalah 46.6%.

Kedua-dua populasi menunjukkan tindakbalas yang berbeza terhadap dua pusingan pemilihan, di mana, dalam populasi Manis Madu, tindakbalas sebenar yang positif hanya diperolehi dalam pusingan pertama (4.1%), manakala tindakbalas sebenar yang negatif diperolehi dalam pusingan kedua (-0.7%). Sebaliknya, populasi kacukan menunjukkan tindakbalas sebenar yang negatif dalam pusingan pertama (-0.7%), manakala tindakbalas sebenar positif yang memadai (2.08%) didapati dalam



pusingan kedua. Purata tindakbalas sebenar kumulatif terhadap pemilihan adalah lebih tinggi dalam M C2 (3.4%) berbanding dengan yang di tunjukkan dalam MS C2 (1.4%). Sebagaimana dijangka, tindakbalas sebenar adalah lebih rendah dari yang diramal.

Dalam analisis gabungan, populasi yang terbentuk selepas dua pusingan pemilihan terhadap Manis Madu (M C2), menunjukkan peningkatan yang ketara bagi hasil tongkol segar dengan kulit ( $10996 \text{ kg ha}^{-1}$ ) dan panjang tongkol tanpa kulit (15.2 cm). Populasi yang terbentuk selepas pusingan kedua pemilihan terhadap populasi kacukan (MS C2) menunjukkan peningkatan yang bererti bagi hasil tongkol segar tanpa kulit, memberikan 6887 dan 6788  $\text{kg ha}^{-1}$  masing-masing di Ladang 2 dan Ladang Kongsi. Dalam analisis gabungan, MS C2 menghasilkan tongkol segar tanpa kulit yang lebih panjang (14.7 cm) berbanding populasi bes, MS C0 (14.5 cm).

Keputusan korelasi mudah fenotip di antara sifat-sifat yang diukur pada sampel individu pokok, di kalangan populasi terpilih, menunjukkan korelasi fenotip yang positif antara ketinggian pokok dengan kebanyakan sifat lain yang dikaji, termasuk ketinggian tongkol, panjang tongkol dan bilangan baris bijian/tongkol. Selain dari itu, korelasi positif juga didapati di antara sifat-sifat tongkol, iaitu panjang tongkol, diameter tongkol, bilangan baris bijian/tongkol dan bilangan bijian/baris.

Panjang tongkol, yang mana diambil sebagai kriteria untuk pemilihan dalam kajian ini, memberikan anggaran kebolehwarisan luas ( $h^2_B$ ) yang sederhana dalam kedua-dua populasi yang dikaji, menunjukkan bahawa pemilihan untuk sifat ini dalam

populasi-populasi tersebut boleh memberikan kesan dalam meningkatkan ukuran sifat ini dalam generasi seterusnya.

Kajian ini telah menunjukkan bahawa kedua-dua germplasma tempatan dan juga yang diimport adalah berguna dalam pembiakbakaan populasi jagung manis. Dua pusingan pemilihan kasar fenotip berdasarkan panjang tongkol yang dijalankan telah menunjukkan sedikit peningkatan hasil tongkol segar dalam kedua-dua populasi. Introgresi gen dari luar ke dalam germplasma tempatan mungkin telah memperluaskan himpunan gen sediaada, walaupun lebih banyak pusingan pemilihan diperlukan untuk mencapai peningkatan genetic yang lebih besar.

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I certify that the Examination Committee met on 5<sup>th</sup> May 2003 to conduct the final Examination of Eltahir Siddig Ali on his Doctor of Philosophy thesis entitled "Genetics and Genetic Response in Populations Generated from Two Cycles of Phenotypic Mass Selection in Sweet Corn (*Zea mays* L. *saccharata*)" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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11 JUL 2003

## DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



**ELTAHIR SIDDIG ALI**

Date: **27/5/2003**

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